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Ignition Coil for an Internal Combustion Engine

The invention is directed to an ignition coil for an internal combustion engine with a substantially cylindrical primary coil base carrying a primary winding, a low voltage connection area for the connection of the primary winding to a low voltage, a secondary winding inductively coupled with the primary winding inductively and disposed on a substantially cylindrical secondary coil base for providing a high voltage for a spark plug of the internal combustion engine, wherein the primary coil base and secondary coil base are positioned concentric to one another, and a high voltage connection area, in which the secondary winding contacts the spark plug.

An ignition coil of this kind is known from DE 100 57 567.

With generic ignition coils, it concerns a so-called “rod coil for ignition equipment of an internal combustion engine”, which includes a long configuration, so that it can be positioned in the narrow, limited space available in the engine block of the internal combustion engine. A primary voltage is applied to the primary winding over the low voltage area, which, as a result of the inductive coupling between the primary and secondary winding, is available as a high transformed voltage to the high voltage connection area of the secondary winding and charges the ignition coil there. With known ignition coils, a magnetic circuit is formed through the primary and secondary coil as well as the cylindrical magnetic coil and the magnetically conductive shell. For the avoidance of eddy current losses in the also metallic, conductive shell, the shell includes a continuous lengthwise slit so that induced electrical eddy currents are minimized.

An important functional feature of such an ignition coil is the so-called “electromagnetic compatibility” (EMC). In this connection, it is a matter of the opposing electromagnetic influence of transmitting and receiving devices. In conjunction with ignition coils, the requirements in relation to the EMC are particularly critical, for example, it must be ensured that the emitted electromagnetic interference of the ignition coil may only indirectly or directly

have no or an acceptably low impact on the radio reception in the vehicle. As a result of the arrangement of the normally open magnetic circuits formed by the ignition coil and the used alternating current frequency, an adequate dampening of electromagnetic interference is not usually provided with traditional ignition coils.

An ignition coil in accordance with the preamble of claim 1 is known from DE 199 27 820 C1. Reference is further made to DE 199 09 211 A1 as prior art.

It is the object of the invention to improve an ignition coil of the above-described kind with respect to its electromagnetic compatibility (EMC) and at the same time with respect to its mechanical stability.

This object is achieved in accordance with the invention in that an electrically conductive, substantially cylindrical formed layer with mechanical dampening characteristics is located within an annular space that is defined by the outermost winding of the two windings. The invention is characterized in that a clear reduction of the electromagnetic emitted interference can be achieved through the conductive layer, which is located between the primary and secondary coils, without depleting the magnetic characteristics of the coil as such. Thereby, the conductive layer located between the primary and secondary coil has surprisingly no influence on the magnetic characteristics of the ignition coil, but instead helps the ignition coil to a substantially improved shielding effectiveness.

It is further provided that the layer is formed as a sandwich structure comprising at least two partial layers with a therebetween lying intermediate layer with mechanical dampening characteristics.

Through the arrangement as a sandwich structure is not only the electromagnetic compatibility (EMC) improved, but particularly also the stability of the ignition coil. The primary and secondary coils are coupled relative to one another, namely in an advantageous manner, through the mechanical cushioning.

Further preferred embodiments are provided from the dependent claims.

The invention will be more specifically described in the following by means of an exemplary embodiment. Thereby illustrates:

Fig. 1	a longitudinal section through an ignition coil in accordance with the exemplary embodiment of the invention;
Fig. 2a	a section along the line II-II in Fig. 1;
Fig. 2b	a section along the line IIb-IIb in Fig. 2a;
Fig. 3	an enlarged view along the line III in Fig. 2a.

Fig. 1 illustrates a longitudinal section through an exemplary embodiment of an ignition coil in accordance with the present invention, which includes a low voltage connection 10 in its upper area, at which the ignition coil is charged with the required low voltage. In its lower area, the ignition coil includes a high voltage connection area 5, in which a connection segment meets a spark plug (not shown).

The ignition coil includes a cylindrical configuration. A cylindrical magnetic core 6 is formed in the interior of the ignition coil and comprises layered magnetic sheets, in particular silicon iron sheets. Several magnetic sheets of different widths are so stacked and connected under insulation of the individual sheets relative to one another to form the core 6 with an approximately circular contour. The core 6 is surrounded by a secondary coil base 4, which supports a secondary winding 3 that is electrically connected with the high voltage connection area 5. The connection of the secondary winding 3 with the high voltage connection area 5 is achieved through a substantially anti-interference serving resistor 11 and a rectifying diode 12, which is housed in a housing 13.

The secondary coil base 4 is concentrically surrounded by a primary coil base 2, which supports a primary winding 1. The primary winding 1 is a three-layered winding in the illustrated exemplary embodiment. The coil unit is surrounded by a sleeve 7, which comprises an electrically conductive and at the same time magnetically conductive material, in particular a silicon iron sheet.

In the illustrated embodiment, the sleeve 7 is formed by two roll-formed magnetic sheets that are insulated from one another. The outer circumference of the sleeve 7 simultaneously forms the outer periphery of the described ignition coil. The sleeve 7, the primary winding 1, the secondary winding 3 and the core 6 form a magnetic circuit for generating the required ignition energy, with which the spark plug is charged. The sleeve 7 is provided with a continuous, lengthwise slit for the purpose of degrading eddy currents in the area of the magnetically conductive sleeve 7. One of the supply leads of the primary winding 1 extends along the lengthwise slit, namely that it is led out of the primary coil base 2 in the lower area of the primary winding 1 and must be coupled with the low voltage connection 10, similar to the supply lead that is led from the upper side of the primary coil base 2. The winding lead running along the lengthwise slit 8 is at the same time fixed within a slit area through an insulation layer, in which the winding lead is fixed in an appropriate embedding material. The embedding is preferably achieved by means of epoxy resin.

The cylindrical formed area between the output of the ends of the secondary winding 3 and the high voltage connection 5 serves on the one hand for the accommodation of the anti-interference serving resistor 11 and on the other hand for the accommodation of the diode 12, through which the rectification of the current flowing in the ignition coil is achieved, such that the negative impulse used for the ignition is allowed to pass, and the positive interfering impulse is, however, suppressed.

Fig. 2a, b illustrate the layer 16 located between the two windings 1, 3, which includes a lengthwise slit 18 for the abatement of eddy currents.

Fig. 3 illustrates the construction of the layer 16 provided in the annular space between the primary and secondary coils in the form of a sandwich structure. An intermediate layer 17 with absorption characteristics is formed between two conductive layers 16a, 16b, wherein the intermediate layer 17 itself also contains conductive particles, which likewise impart conductive characteristics to the intermediate layer 17.

Through the layer 16, the ignition coil on the one hand achieves an improved EMC – compatibility as a result of the improved shielding effectiveness, and the primary and secondary coil bodies are, on the other hand, substantially better cushioned relative to one another. The layer 16 is therewith coupled with ground. Thus, interference voltages, which could capacitively overcouple from the secondary winding to the primary winding, are electrically shorted. The connection of the layer 16 with ground is achieved, such that one of the two sub-layers 16a, 16b is electrically connected with the winding area of the primary winding 1 lying on ground. For this, the primary winding 1 is not insulated at the corresponding winding portion and through soldering or similar connection techniques contacts the corresponding partial layer. Alternative thereto, a connection technique is also possible, by which an additional conductor is provided, which couples the corresponding partial layer 16a, 16b with the winding end of the primary coil 1.